Data Article

Data from a dynamic simulation in a free-floating and continuous regime of a solar greenhouse modelled in TRNSYS 17 considering simultaneously different thermal phenomena

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A R T I C L E   I N F O

A B S T R A C T

This dataset supports the research article "Complete greenhouse dynamic simulation tool to assess the crop thermal well-being and energy needs" [1]. In the agricultural sector, the use of energy can be very intensive [2] and the simulation of solar greenhouses is a very complex work [3]. This dataset provides the results of thermal modeling and dynamic simulation of a solar greenhouse considering simultaneously several thermal phenomena. The analysis was performed by TRNSYS 17 software (TRaNsient SYstem Simulation). The results obtained consider different phenomena that affect the thermal behavior of the greenhouse, including evapotranspiration produced by plants, heat exchange with the soil and the presence of artificial lights. Different models are presented for the calculation of the convective coefficient that best suits the presence of glass surfaces, considering the different discretization of the internal volume (single thermal

zone and twenty thermal zones). The parameters that influence the thermal behavior of the greenhouse are analyzed on an hourly basis, the model has been validated with EnergyPlus. The data allow the researcher to choose a suitable greenhouse model in the case of free-floating model or in the presence of an air conditioning system.

Specifications Table

Subject	Energy
Specific subject area	Design of greenhouse considering simultaneously different thermal phenomena.
Type of data	Table
How data were acquired	Climate datasheets, analysed and processed output data by the software TRNSYS 17.
Data format	Raw Data
Parameters for data collection	This data set provides the analysis of a solar greenhouse with symmetrical flat pitched roofs with the longest sides facing south and north. The materials that constitute the greenhouse are those traditionally used in greenhouses located in the Crotone area. The solar greenhouse was modeled considering the presence of lamps and evapotranspiration necessary for the cultivation of chrysanthemum. Two models have been developed characterized by different discretization of its internal volume, namely a greenhouse with a single thermal zone and a greenhouse with twenty thermal zones. Moreover, all the parameters that influence the thermal balance of the greenhouse have been analysed in a free-floating and continuous regime.
Description of data collection	TMY2 weather files from the U.S. National Renewable Energy Laboratory (NREL) [4] are used to reproduce the climate data of the city of Crotone in Italy, where the solar greenhouse is located. The climatic data are processed with a 1-h step for a total duration of 8760 h. The building model has been designed through TRNbuild, an add-on of TRNSYS 17. The results of simulations are reported in terms of internal air temperature, energy requirements, evapotranspiration mass flow, natural ventilation air mass flow. The model has been validated and compared with the same solar greenhouse simulated with EnergyPlus software.
Data source location	City: Crotone [39.0823 17.10997]. Country: Italy. Climate data: TMY2 weather files [4]
Data accessibility	With the article
Related research article	Cristina Baglivo, Domenico Mazzeo, Simone Panico, Sara Bonuso, Nicoletta Matera, Paolo Maria Congedo, Giuseppe Oliveti, Complete greenhouse dynamic simulation tool to assess the crop thermal well-being and energy needs, Applied Thermal Engineering, 2020, 115698, ISSN 1359-4311, 10.1016/j.applthermaleng.2020.115698 [1].

Value of the Data

- The data support energy efficiency as they can be the basis for the implementation of actions to reach the nZEG (nearly Zero Energy Greenhouse) targets.
- Presented data enable researchers to improve the methodology for greenhouse design by considering different discretization of its internal volume.

- The data lead to compare the case study with several typologies of greenhouse placed in other locations of the world characterized by different climate conditions.
- The data provide quantitative information about the greenhouse model considering the standard and detailed radiation mode, the presence and the absence of TRNFlow tool, the use of virtual surfaces and virtual windows.

1. Data Description

The calculation has been performed for a Venlo solar greenhouse [5], characterized by 28 independent spans, each of which covers an area (S) of 500 m^2 with a volume (V) of 2750 m^3. The greenhouse is in Crotone on the eastern side of Calabria, characterized by a temperate climate [6] and classificate as Csa for the Köppen Climate Classification [7].

The climatic data of Crotone used for the simulation are extracted from TMY2 weather files from the U.S. National Renewable Energy Laboratory (NREL) [4]. The climatic data (in terms of horizontal global solar radiation, external dry air temperature, dew point temperature, effective sky temperature, humidity ratio, percentage relative humidity, wind velocity, wind direction and atmospheric pressure) are processed with a 1-h step for a total duration of 8760 h.

The greenhouse is modelled using two different solar greenhouse geometries:

- the first configuration is represented by a single zone (1Z);
- the second configuration consists of the solar greenhouse divided into twenty zones (20Z), five along the x-axis and four along the z-axis.

For each geometry several simulations have been performed including *detailed radiative mode* and the use of the *TRNFlow* plugin. The first permits the calculation of solar radiation through the glass surfaces using the view factors. *TRNFlow* allows to consider air mass exchanges between zones. The presence of *Virtual Surfaces* and *Virtual Windows* is necessary for the construction of the 20 zones geometry, but their presence does not allow the simulation with *detailed radiation mode* and *TRNFLOW*.

Table 1 shows for each geometry the combinations (Combo) of the calculation set-ups, depending on the presence or not of *Virtual Surfaces* or *Virtual Windows*.

The "File 1 – Internal air temperature" presents hourly internal air temperature for the solar greenhouse with one zone (1Z) and the greenhouse divided into twenty zones (20 Z), for all combinations listed in Table 1. For the 20 zones, the air temperatures have been listed for each of the 20 zones of which the greenhouse is composed, H indicates the horizontal distances and V indicates the vertical ones.
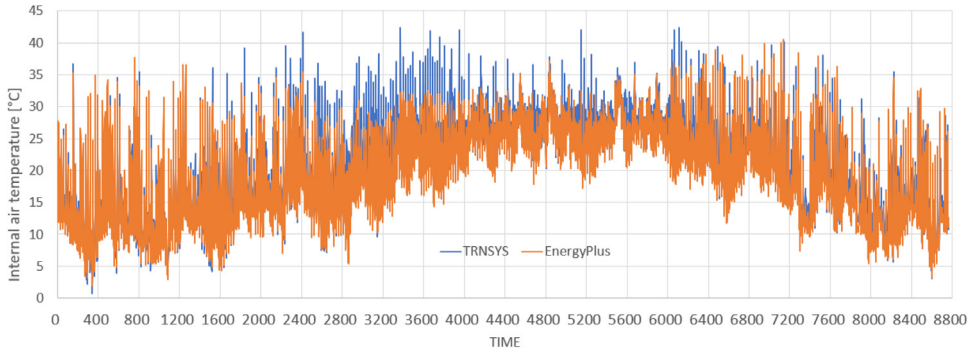
The "File 2 – Energy requirements" shows hourly energy requirements in kJ/h of the combinations listed in Table 1.

The study considers the growth of the chrysanthemum, the evapotranspiration produced by the plant influences the simulation. The outputs are reported in "File 3 – Evapotranspiration mass flow". The details of the calculations are presented in [1].

File 4 "Natural ventilation air flow rate" contains, for Combo 1, the natural ventilation air mass flows activated by large openings place on the bottom and top part of the longest side of

Table 1
List of combinations.

Zones	Combinations	Detailed radiation mode	TRNFlow mode	Virtual Surface	Virtual Windows
1Z	Combo 1	-	-	-	-
	Combo 2	√	-	-	-
	Combo 3	-	√	-	-
	Combo 4	√	√	-	-
20Z	Combo 1	-	-	√	√
	Combo 3	-	√	√	√

Fig. 1. Values of internal air temperature obtained with TRNSYS and EnergyPlus for the Combo 1.

the greenhouse. The natural ventilation is properly managed by a controller dependent on the internal and external air temperatures, to provide a free-heating or free-cooling to the greenhouse environment.
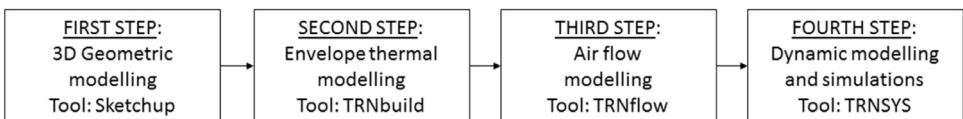
The simulation model built in TRNSYS environment is validated with EnergyPlus 8.6, the calculation details are reported in the Related research article. File 5 "Validation model" contains the internal air temperature of the greenhouse obtained with the two software and the percentage relative error. Validation is carried out for the Combo 1. The Fig. 1 presents the values of internal air temperature obtained with TRNSYS and EnergyPlus.

2. Experimental Design, Materials and Methods

Several steps are sequentially developed to model the greenhouse considering both the geometric and physical aspects (Fig. 2).

The dynamic simulations have been carried out using TRNSYS 17 (TRaNsient SYstem Simulation) tool [8]. The specific Types used for the calculations are:

- Type 15 (Weather data) related to the generation of weather data starting from a meteorological data file .tm2 from Meteonorm;
- Type 56 (Greenhouse data) for the principal component able to characterize the dynamic thermal performance of the greenhouse divided into thermal zones, characterized by air nodes defined in TRNBuild;
- Type 77 (Ground temperature data) for the ground characterization;
- Type 661 (Type661_Tai_Tae and Type661_Qet) to control the outputs that are set to the input values from a user-defined previous time step;
- Equation blocks for the static converters and the calculation of:
    - Evapotranspiration;
    - MoWitt model;
    - Boolean parameter and air exchanges;
    - TRNflow model;
- Type 25 (Result data) allows printing results.

FIRST STEP:	SECOND STEP:	THIRD STEP:	FOURTH STEP:
3D Geometric modelling Tool: Sketchup	Envelope thermal modelling Tool: TRNbuild	Air flow modelling Tool: TRNflow	Dynamic modelling and simulations Tool: TRNSYS

Fig. 2. Development of the methodology.

Ethics Statement

The authors gave their consent to apply the instrument and provide the necessary data.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

Supplementary Materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.dib.2020.106339.

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